A Comparison of the Effect of Dexmedetomidine and Esmolol in Attenuating Stress Responses during Laparoscopic Surgeries

Priyamvada Gupta, Manisha Agrawal, Durga Jethava, DD Jethava

ABSTRACT

Introduction: The creation of pneumoperitoneum leads to increased mean arterial pressure and systemic vascular resistance as a result of stimulation of the sympathetic system leading to increased release of catecholamines and vasopressin. In order to prevent these hemodynamic changes, various pharmacological agents like clonidine, esmolol, or dexmedetomidine are used. Hence, there is need for this study.

Materials and methods: A total of 60 patients were randomized into two equal groups: group D—dexmedetomidine was administered as loading dose 1 µg/kg administered slowly over 15 minutes before induction followed by maintenance infusion of 0.5 µg/kg/hour throughout the period of pneumoperitoneum. Group E—esmolol was administered as loading dose at 1 mg/kg administered slowly over 5 minutes before induction followed by maintenance infusion of 0.5 mg/kg/hour throughout the period of pneumoperitoneum. Intraabdominal pressure was maintained at 12 to 14 mm Hg throughout the procedure. The infusions were discontinued immediately after the release of pneumoperitoneum. Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at frequent intervals as per the pro forma. Data were analyzed using appropriate statistical tests.

Results and conclusions: As compared with esmolol, dexmedetomidine is more effective for attenuation of the pressor responses to pneumoperitoneum and thus achieving hemodynamic stability during laparoscopic surgeries (p < 0.05).

Keywords: Dexmedetomidine, Esmolol, Laparoscopic, Pneumoperitoneum.

INTRODUCTION

Laparoscopic procedure has benefits over open surgical procedure in terms of minimal invasion, decreased tissue damage, decreased operative time, and morbidity. But the creation of pneumoperitoneum leads to increased heart rate and mean arterial pressure as a result of the involvement of sympathetic system leading to increased release of catecholamines and vasopressin. These hemodynamic disturbances may be detrimental in patients with poor cardiac reserve. Hence, in order to prevent these hemodynamic changes, various pharmacological agents like clonidine, esmolol, or dexmedetomidine have been used.

Dexmedetomidine is alpha-2 adrenergic receptor agonist that modulates the hemodynamic changes by inhibiting the release of catecholamines and vasopressin. Esmolol, an ultrashort-acting cardioselective beta-1 antagonist, has also been used to control tachycardia and hypertension. Hence, we performed this study so as to compare the efficacy of these two agents and also to compare the safety of these drugs.

MATERIALS AND METHODS

This prospective randomized single-blind control study was conducted at Mahatma Gandhi Medical College and Hospital, Jaipur, India. A total of 60 patients were included in the study.

Inclusion Criteria

Age 20 to 60 years, American Society of Anesthesiologist (ASA) physical status I/II, either gender, posted for laparoscopic surgery to be performed under general anesthesia. The exclusion criteria included: ASA grade III/IV, hypertension, diabetes, ischemic heart diseases, cerebrovascular insufficiency, morbid obesity, age <20 or >60 years, allergy to study medications, renal/hepatic insufficiency, patients on antipsychotic, or antihypertensive medication. Pregnant or lactating females were also excluded. Patients were randomized with the help of chit in box method into two groups of 30 each.

Group D—Injection dexmedetomidine was administered as loading dose infusion at 1 µg/kg slowly over 15 minutes before induction followed by maintenance
infusion of 0.5 µg/kg/hour administered throughout the period of pneumoperitoneum.

Group E—Injection esmolol was administered as loading dose infusion at 1 mg/kg slowly over 5 minutes administered before induction followed by maintenance infusion of 0.5 mg/kg/hour continued throughout the period of pneumoperitoneum.

On arrival in operating room, standard monitoring was attached. All patients were preoxygenated with 100% O₂ for 5 minutes and induced with standardized doses of midazolam, fentanyl, and propofol intravenously. Orotracheal intubation was facilitated with injection Vecuronium bromide and achieved with cuffed endotracheal tube of size as appropriate. Anesthesia was maintained with oxygen:nitrous oxide (40:60), isoflurane, and injection Vecuronium. Throughout the procedure, intraabdominal pressure was maintained at <14 mm Hg. The infusions of the study drugs were discontinued immediately after the release of pneumoperitoneum. Reversal of neuromuscular blockade was achieved with injection Neostigmine and injection Glycopyrrolate.

Hemodynamic variables were recorded at various time intervals: preoperative (baseline), just after the administration of study drug, immediately after induction, just after intubation, after creation of pneumoperitoneum and thereafter at regular intervals of 15 minutes, just after release of pneumoperitoneum, and then after 15 minutes. The quantitative data were expressed as mean ± standard deviation (SD) and qualitative data as percentage. The qualitative data were analyzed using Chi-square test and quantitative data were analyzed using Student’s t-test; p-value < 0.05 was considered statistically significant.

RESULTS

The study groups were statistically identical (p > 0.05) (Table 1). The baseline heart rate was statistically identical in both groups. After administration of study drugs also, there was no statistically significant difference in the heart rate in both the groups. After induction and intubation there was increase in heart rate in group E but not in group D (Table 2 and Graph 1). After the creation of pneumoperitoneum and during pneumoperitoneum, there was significant increase in heart rate in group E as compared with group D (p = 0.001) (Table 2 and Graph 1). Similarly, there was

<table>
<thead>
<tr>
<th>Table 1: Demographic variables</th>
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<td>Groups</td>
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<td>N</td>
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<td></td>
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</tbody>
</table>

|        | Group D     | 30          | 30        | 30        |
|        | Group E     | 30          | 30        | 30        |
| N      | Mean        | 81.20       | 72.87     | 74.90     |
|        | SD          | 13.90       | 13.32     | 13.66     |
|        | p-value     | 0.105       | 0.087     | 0.010     |
no significant difference in systolic blood pressure and diastolic blood pressure between groups at baseline, after administration of study drugs, induction, and intubation. Systolic blood pressure and diastolic blood pressure were higher in group E as compared with group D after creation of pneumoperitoneum and during pneumoperitoneum (Graphs 2 and 3; Tables 3 and 4, respectively). In addition, there was no significant difference in baseline mean arterial pressure between the groups. However, mean arterial pressure was significantly higher in group E as compared with group D at the time of creation of pneumoperitoneum and during pneumoperitoneum (Table 5 and Graph 4).
Table 3: Systolic blood pressure at various points of time

<table>
<thead>
<tr>
<th>Groups</th>
<th>Baseline</th>
<th>After drug int</th>
<th>Induction</th>
<th>Intubation</th>
<th>Pneumoperitoneum</th>
<th>5 min</th>
<th>10 min</th>
<th>20 min</th>
<th>30 min</th>
<th>Postpneumo</th>
<th>Extubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group D N 30</td>
<td>132.63</td>
<td>131.73</td>
<td>139.90</td>
<td>127.53</td>
<td>114.57</td>
<td>121.27</td>
<td>117.60</td>
<td>115.57</td>
<td>113.57</td>
<td>111.90</td>
<td>141.43</td>
</tr>
<tr>
<td>Mean</td>
<td>132.63</td>
<td>131.73</td>
<td>139.90</td>
<td>127.53</td>
<td>114.57</td>
<td>121.27</td>
<td>117.60</td>
<td>115.57</td>
<td>113.57</td>
<td>111.90</td>
<td>141.43</td>
</tr>
<tr>
<td>p-value</td>
<td>0.247</td>
<td>0.420</td>
<td>0.007</td>
<td>0.030</td>
<td>0.001</td>
<td>&lt;0.001, S</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001, S</td>
<td>&lt;0.001, S</td>
<td>&lt;0.001, S</td>
</tr>
</tbody>
</table>

S: Significant

Table 4: Diastolic blood pressure at various points of time

<table>
<thead>
<tr>
<th>Groups</th>
<th>Baseline</th>
<th>After drug int</th>
<th>Induction</th>
<th>Intubation</th>
<th>Pneumoperitoneum</th>
<th>5 min</th>
<th>10 min</th>
<th>20 min</th>
<th>30 min</th>
<th>Postpneumo</th>
<th>Extubation</th>
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</thead>
<tbody>
<tr>
<td>Group D N 30</td>
<td>100.23</td>
<td>96.97</td>
<td>105.50</td>
<td>95.43</td>
<td>88.03</td>
<td>93.43</td>
<td>90.37</td>
<td>86.83</td>
<td>84.17</td>
<td>85.90</td>
<td>106.47</td>
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<tr>
<td>Mean</td>
<td>100.23</td>
<td>96.97</td>
<td>105.50</td>
<td>95.43</td>
<td>88.03</td>
<td>93.43</td>
<td>90.37</td>
<td>86.83</td>
<td>84.17</td>
<td>85.90</td>
<td>106.47</td>
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<tr>
<td>p-value</td>
<td>0.370</td>
<td>0.539</td>
<td>0.039</td>
<td>0.441</td>
<td>0.001</td>
<td>0.027</td>
<td>0.082</td>
<td>0.016</td>
<td>0.002, S</td>
<td>0.002</td>
<td>0.044</td>
</tr>
</tbody>
</table>

S: Significant

Table 5: Mean blood pressure at various points of time

<table>
<thead>
<tr>
<th>Groups</th>
<th>Baseline</th>
<th>After drug int</th>
<th>Induction</th>
<th>Intubation</th>
<th>Pneumoperitoneum</th>
<th>5 min</th>
<th>10 min</th>
<th>20 min</th>
<th>30 min</th>
<th>Postpneumo</th>
<th>Extubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group D N 30</td>
<td>78.60</td>
<td>76.53</td>
<td>79.60</td>
<td>78.53</td>
<td>79.60</td>
<td>79.60</td>
<td>78.53</td>
<td>79.60</td>
<td>78.53</td>
<td>79.60</td>
<td>79.60</td>
</tr>
<tr>
<td>Mean</td>
<td>78.60</td>
<td>76.53</td>
<td>79.60</td>
<td>78.53</td>
<td>79.60</td>
<td>79.60</td>
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<td>78.53</td>
<td>79.60</td>
<td>79.60</td>
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<tr>
<td>SD</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
<td>11.89</td>
</tr>
<tr>
<td>p-value</td>
<td>0.744</td>
<td>0.365</td>
<td>0.010</td>
<td>0.041</td>
<td>0.000</td>
<td>0.021</td>
<td>0.113</td>
<td>0.005</td>
<td>0.004S</td>
<td>0.000</td>
<td>0.045</td>
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</table>
Hypotension was observed in one patient in group D which responded well to intravenous bolus of 200 mL Ringer’s lactate. There were no other complications in either group.

**DISCUSSION**

The creation of pneumoperitoneum during laparoscopic surgeries caused a rapid increase in plasma catecholamines and vasopressin leading to elevated arterial pressure, systemic vascular resistance, and heart rate. Increase in hemodynamic parameters leads to increase in the incidence of complications like myocardial ischemia and infarction. To attenuate these hemodynamic changes, various pharmacological agents were used. In the present study, dexmedetomidine and esmolol were compared because both are short-acting and inhibit the release of catecholamines.

Dexmedetomidine is highly selective alpha-2 adrenergic receptor agonist that provides excellent sedation and analgesia with minimal respiratory depression. Esmolol is an ultrashort-acting, cardioselective beta-1 receptor antagonist having little sedative effect, but no analgesic activity. In a study it was observed that esmolol had an opioid sparing effect during and immediately after laparoscopic surgeries. Some researchers have used esmolol in an initial bolus of 1 mg/kg before pneumoperitoneum and followed by an infusion of 0.2 mg/kg/hour. They observed that esmolol was effective in attenuating the increase of heart rate and arterial pressure during laparoscopic surgeries. In yet another study, administering the single dose, it was reported that dexmedetomidine was more effective in preventing the rise in heart rate and blood pressure during extubation because of its additional analgesic and sedative action. Shams et al used same loading and infusion dose of dexmedetomidine and esmolol in functional endoscopic sinus surgeries for providing hypotensive anesthesia and found that dexmedetomidine is more effective than esmolol with added advantages of its sedative effects. In a study comparing esmolol and dexmedetomidine with control group, it was observed that both the drugs were effective in attenuating pressor responses during laparoscopic surgeries. In yet another study, it was observed that esmolol was better in terms of stability of heart rate as compared with the dexmedetomidine group which showed a better control in blood pressure. However, in our study, we observed that dexmedetomidine group was better in terms of stability of both heart rate and blood pressure as compared with esmolol group. We did not compare the observations with control group.

**CONCLUSION**

Thus, we conclude that dexmedetomidine is better than esmolol in prevention of pressor responses to pneumoperitoneum created during laparoscopic surgeries.
REFERENCES


